NEW YORK STATE DEPARTMENT OF TRANSPORTATION

Intelligent Transportation Systems (ITS) Study

for the

Buffalo and Niagara Falls Metropolitan Area

Erie and Niagara Counties, New York

Final Report

June 18, 1997

Prepared by: **DE LEUW, CATHER & COMPANY OF NEW YORK, INC.**

In association with:
AE Group
Clough, Harbor & Associates
Calspan Corporation
IBI Group

New York State Department of Transportation

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TECHNICAL SUMMARY

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1.0 INTRODUCTION

This document provides a technical summary for the seven working papers prepared for the New York State Department of Transportation (NYSDOT) Buffalo and Niagara Falls Intelligent Transportation System (ITS) Study.

ITS is the use of modern computers and communications to improve traffic and transit system flow and safety. Examples of ITS are advanced traffic control systems to monitor and control flow, and incident detection and management systems to quickly locate and respond to accidents and breakdowns disrupting traffic operations.

The main objectives of the ITS Study were to evaluate the transportation needs of the Buffalo/Niagara Falls region; to make an assessment of the ability of ITS to meet these needs; and to develop an ITS implementation strategy.

In order to meet these objectives, smaller goals had to be met throughout the study. These goals included: determining existing transportation system deficiencies, identifying any current ITS systems, developing a critical stakeholder outreach program, determining required user services, researching alternative technologies, developing the system architecture, and finally recommending a strategic ITS plan.

This technical summary presents an overview of the ITS Study. Further details can be found in the Working Papers following the summary.

1.1 PROJECT STUDY AREA

The project study area is located at the eastern end of Lake Erie and consists of Erie County, Niagara County, and the Niagara Region of southern Ontario, as shown in Figure 1-1. The major population centers of Buffalo, Niagara Falls and Niagara Falls, Ontario, as well as the towns of Amherst, Tonawanda and Cheektowaga have a population of over 1.9 million people. About 10 million tourists visit the Niagara Falls area annually.

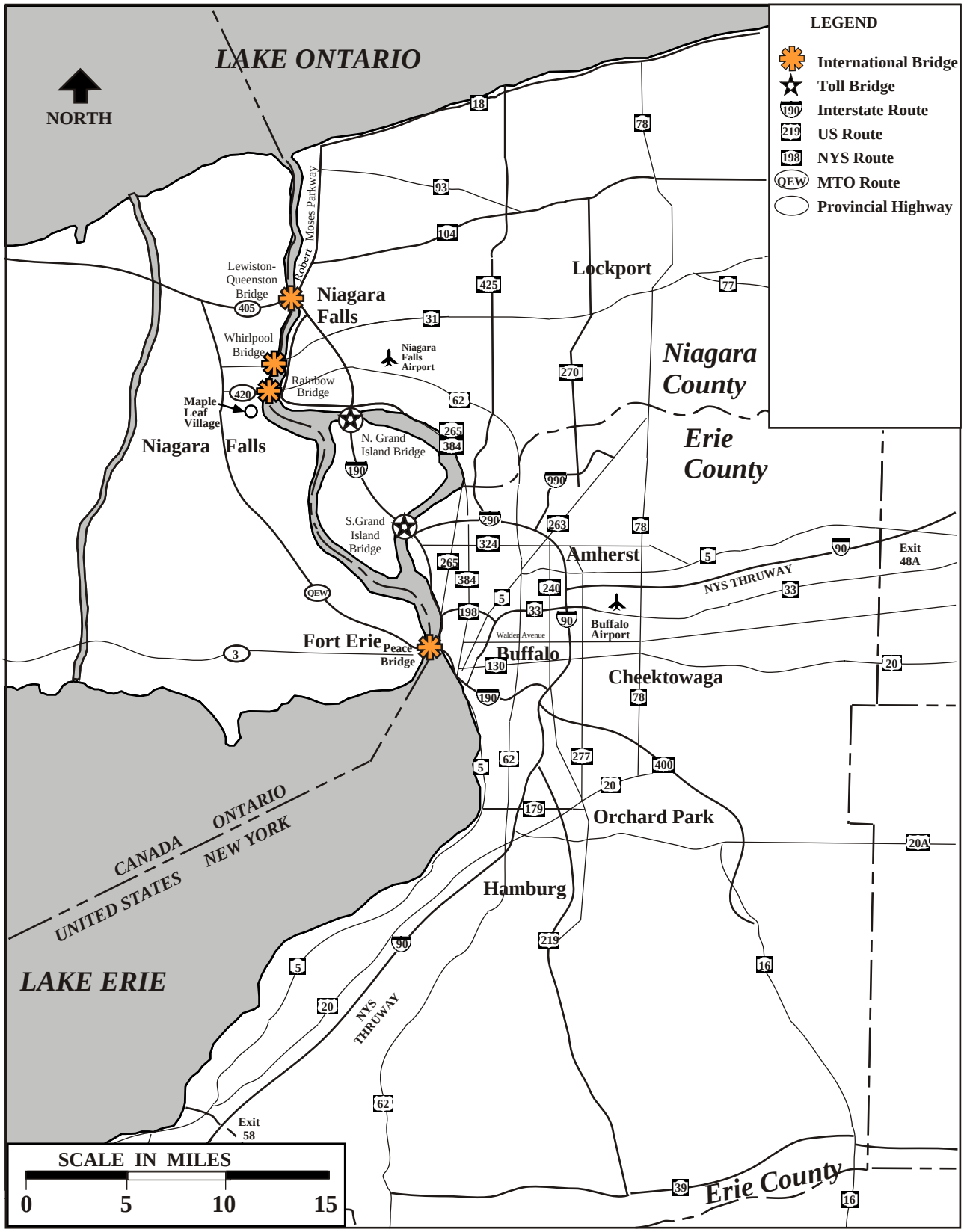

Figure 1-1 Regional Project Area

2.0 EXISTING TRANSPORTATION SYSTEMS

This section provides a discussion of the existing characteristics of the transportation system in the Buffalo, Niagara Falls, and southern Ontario region. The region is a major avenue for international trade and has a major tourist attraction in Niagara Falls. This diversity produces two very different travelers, commercial and business travelers, and recreational travelers. The following sections provide an overview of the area with a discussion of the major National Highway System routes and existing ITS.

2.1 NATIONAL HIGHWAY SYSTEM

The New York State Thruway Authority and various major interstate highways and expressways provide the opportunity for significant international travel by connecting four USA/Canada international bridge crossings with the rest of the State to the east, south and southeast. The New York State Thruway (I-90) provides an important connection between New York State/New England and destinations west for both commercial and private vehicles.

The Buffalo urban transportation network was designed (by Joseph Ellicott) as a wheel with spokes radiating outward from the downtown Buffalo area. The New York State Thruway (I-90) and Niagara Section (I-190) plus the NYSDOT Youngmann Expressway (I-290) form an outer loop. The Scajaquada Expressway (NY 198) and a portion of the Kensington Expressway (NY 33) form an inner loop. The Kensington Expressway also provides the primary connection between Downtown Buffalo and the Greater Buffalo International Airport. The Niagara Falls recreational area can be accessed from the American side via I-190 and the Robert Moses Parkway, as well as local arterial streets.

2.2 EXISTING INTELLIGENT TRANSPORTATION SYSTEMS (ITS)

The region has some basic ITS elements today. There is traffic surveillance equipment in place throughout the region, several traffic operation centers, and a few data dissemination system elements (highway/weather advisory radio as well as fixed and variable message signs). Additionally, the region has some advanced ITS systems including electronic toll collection. These systems will be the building blocks for a regionwide ITS.

2.2.1 Traffic Surveillance Systems

Traffic surveillance systems are an important part of ITS. Surveillance systems are used to detect roadway usage, travel conditions, and incidents. This information is useful for planning, operations and emergency dispatch. Within the project area, closed circuit television (CCTV) is currently used by the Buffalo and Fort Erie Public Bridge Authority (PBA) and Niagara Falls Bridge Commission (NFBC) to monitor traffic conditions along the US/Canada border crossings. Vehicle detectors (inductive loops) have been installed in the pavement by the NYSDOT and the NYSTA to monitor traffic. There are currently more than 100 vehicle detector stations installed on the freeway system. These detectors, however, do not currently have the ability to provide traffic volumes in a real-time

manner but can be upgraded to do so. Figure 2-1 shows the existing detectors and Figure 2-2 shows the committed (e.g., funded but not necessarily installed) detectors that are located on the freeway system.

There is also a traffic conditions reporting hot-line (*TIP) that travelers can dial with their cellular telephones to report incidents and congestion. This program is sponsored by Metro Networks. Metro Networks subsequently provides traffic reports to radio and television stations. Other telephone call-in systems are also operated throughout the region. These are:

- 911 - Erie County Sheriff
- *AAA (Cellular) - American Automobile Association
- 800-847-8929 - New York State Thruway Authority
- 888-648-3262 - Niagara International Transportation Technology Coalition (NITTEC) (USA & Canada)
- 716-847-3973 - NITTEC (local Buffalo area only).

2.2.2 Electronic Toll Collection

The New York State Thruway Authority (NYSTA) has an electronic toll collection system (EZ-Pass), which consists of a windshield mounted module that transmits information to and from the EZ-Pass stations. The system allows users to pass through toll plazas at speeds of up to 5 mph and automatically charges the toll amount to the user's account. The speed limit is not based on technology, but rather the toll barrier configuration.

2.2.3 Expedited Customs and Immigration

Congestion occurs along the project area US/Canada border crossings (Peace Bridge, Rainbow Bridge, Whirlpool Bridge and Lewiston-Queenston Bridge) during the morning, evening and weekend peak hours. The Intelligent Transportation Border Crossing System (ITBCS) is a project which will utilize expedited customs and immigration techniques to help reduce congestion and delay at border crossings. The ITBCS is currently under study for implementation at the Peace Bridge. Other border crossings are utilizing customs pre-clearance, customs nationality lanes, surveillance cameras, and automatic license plate reading systems. The customs pre-clearance currently consists of an immigration pass (Auto-Pass) that frequent users can utilize. The Auto-Pass user is still subject to random inspections.

2.2.4 Skyway Closing System

Due to low visibility and high winds, the raised portion of NY 5 adjacent to Lake Erie (the Skyway) is occasionally closed to traffic. When such poor driving conditions exist, the Skyway is closed by an electronic system of fixed message signs and flashers. The Buffalo Police Department determines when to close the Skyway and via modem and radio activates fixed message signs at both ends of the Skyway (see Figure 2-3).

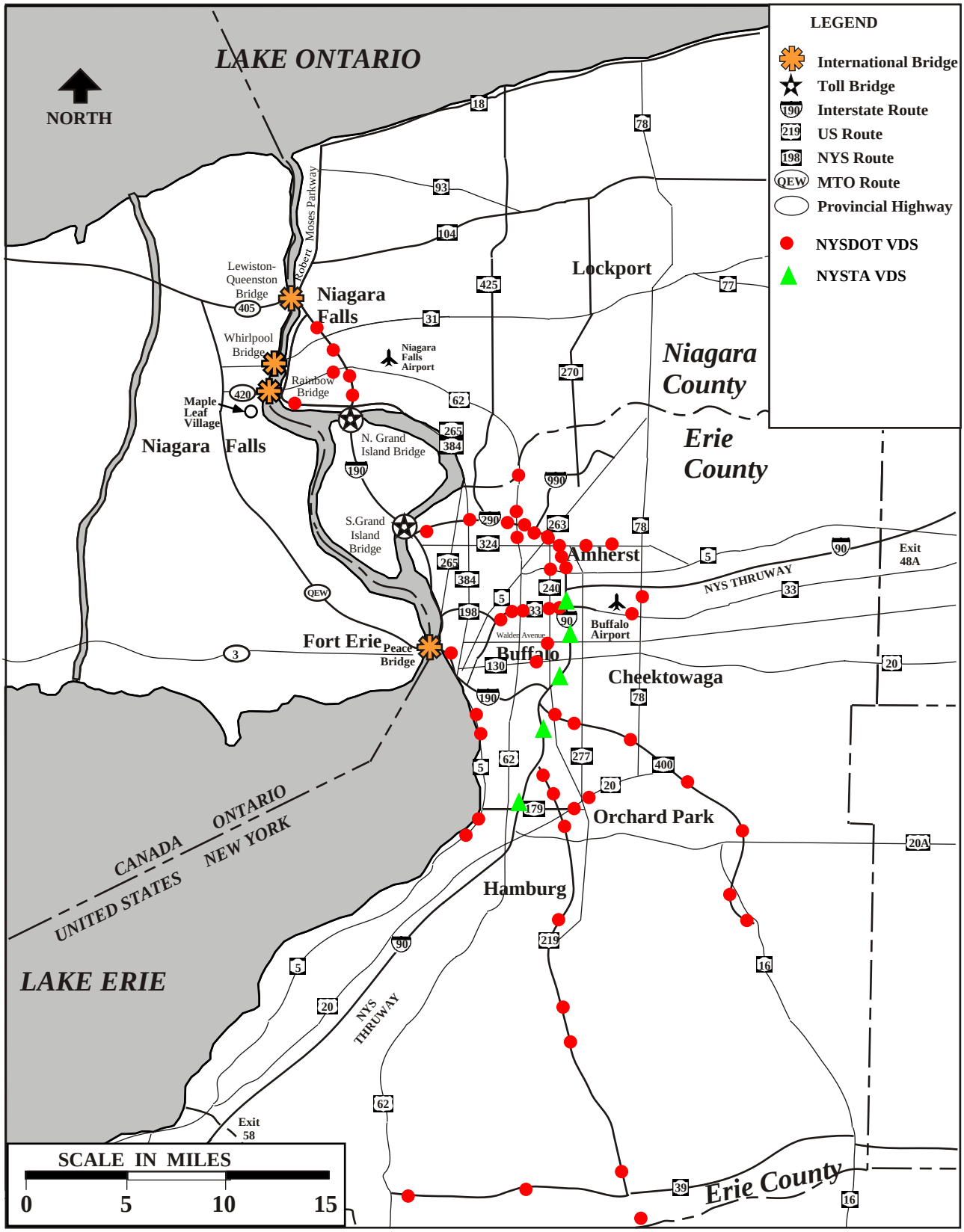

Figure 2-1 Existing Vehicle Detector Stations (VDS)

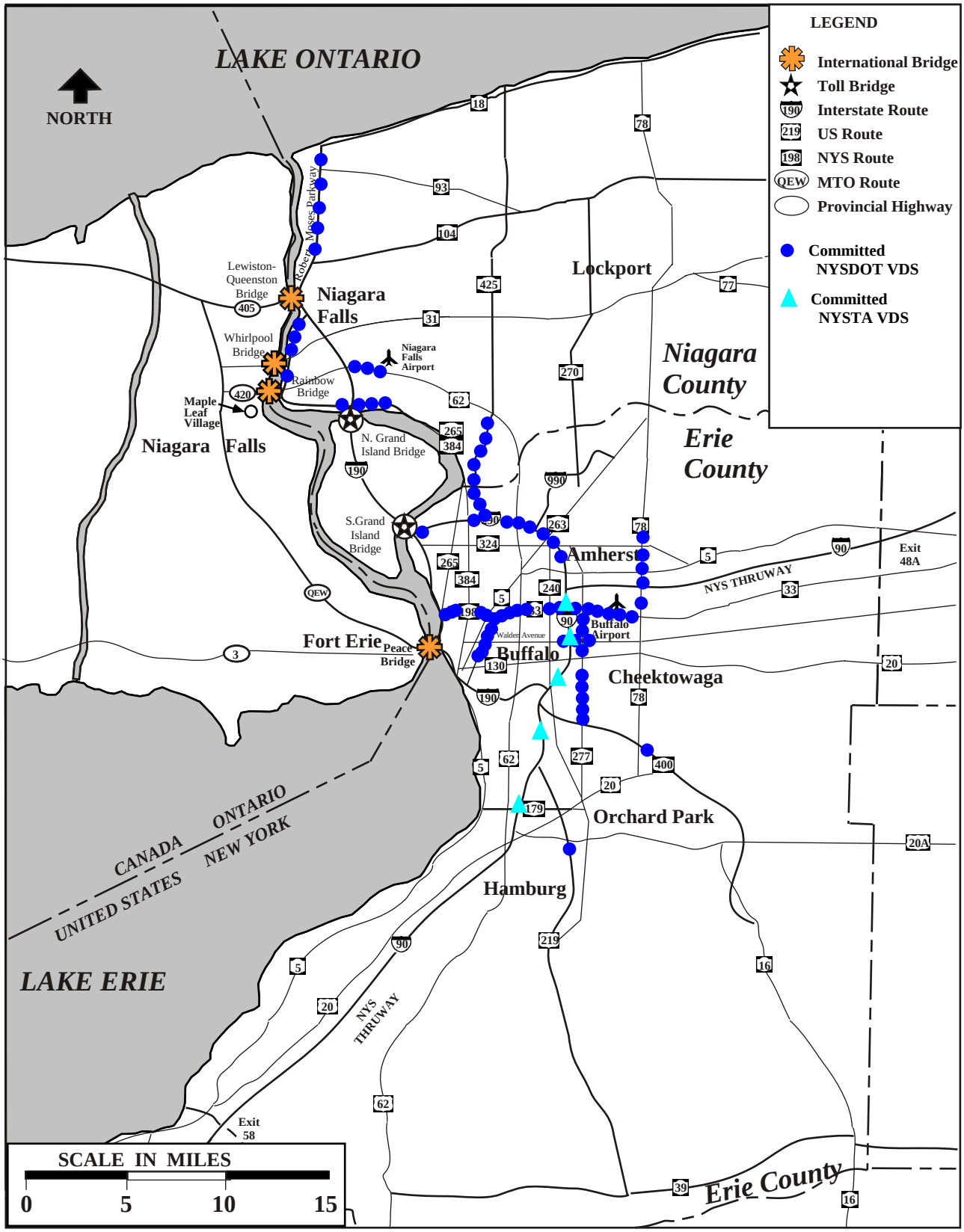

Figure 2-2 Committed Vehicle Detector Stations (VDS)

2.2.5 Variable Message Signs (VMSs)

In the study area, the NYSTA owns and operates thirteen VMSs and the PBA owns and operates a VMS located along northbound I-190 just south of the Porter Avenue exit. The VMSs are currently used to provide traffic information to motorists. But, since there is not an automated surveillance system, these VMSs do not convey as much information to the motorists as they could, causing the motoring public to question their usefulness. With proper support surveillance, however, these signs will become an important part of the Buffalo/Niagara Falls ITS in the future. Existing and committed VMS locations are shown in Figure 2-3.

2.2.6 Highway Advisory Radio (HAR) / Weather Advisory Radio (WAR)

The NYSTA operates a Highway Advisory Radio with coverage along most of the NYSTA roadways throughout the region. The National Oceanic and Atmospheric Administration operates a weather radio station at the Buffalo Airport, and the Niagara Parks Commission and the Niagara Falls Bridge Commission jointly operate a Travel Advisory Radio Station. Coverage for these are shown in Figure 2-4.

2.2.7 Advanced Public Transportation Systems

The Niagara Frontier Transportation Authority (NFTA) operates an automated pre-trip schedule notification system that can be accessed by phone. The caller punches in the route number, origin, and destination and receives the next available departure and arrival times.

The NFTA is also in the process of installing Automatic Vehicle Location devices (AVL) on all NFTA buses and other vehicles (370 vehicles total). The AVL devices will utilize Global Position Satellite technology over microwave radio to enable vehicle tracking and improved schedule management.

2.2.8 Park-and-Ride Facilities

Park-and-Ride facilities provide parking for commuters who use a personal vehicle to commute to a common meeting place and then ride public transit or carpool to their final destination. Existing Park-and-Ride facilities offer the potential to be integrated into the ITS infrastructure by providing traveler information display kiosks. There are currently eight Park and Ride facilities located within the study area.

2.2.9 Coordinated Signals

Coordinated signals are used to minimize stops and delay along major arterials. Properly coordinated signals can reduce travel times, vehicle queuing, traveler costs and negative environmental effects. There are several efforts underway to provide coordinated signals as shown in Figure 2-5.

2.2.10 Existing Traffic Operations Center (TOC) Facilities

Currently various ITS components are being controlled and operated out of individual TOCs by the New York State Thruway Authority (VMSs and HAR), the New York State Department of Transportation (Skyway Fixed Message Signs (FMSs)), the Buffalo and Fort Erie Public Bridge Authority (VMS and CCTV), the Niagara Falls Bridge Commission (CCTV and FMSs), and the Niagara Frontier Transportation Authority (transit, train, signal controls, and CCTV). The existing CCTV locations are shown in Figure 2-5.

The Niagara International Transportation Technology Coalition (NITTEC) also operates a Regional Operations Center (ROC), currently housed at NYSDOT, Region 5. This interim ROC aims to coordinate the NYSDOT, NYSTA, PBA, Ontario Ministry of Transportation (MTO) and the NFBC systems. Issues regarding the degree of control at the ROC are the subject of continuing discussions among NITTEC members.

Figure 2-3 Variable Message Signs (VMS)

Figure 2-4 Existing and Committed Highway Advisory Radio (HAR)

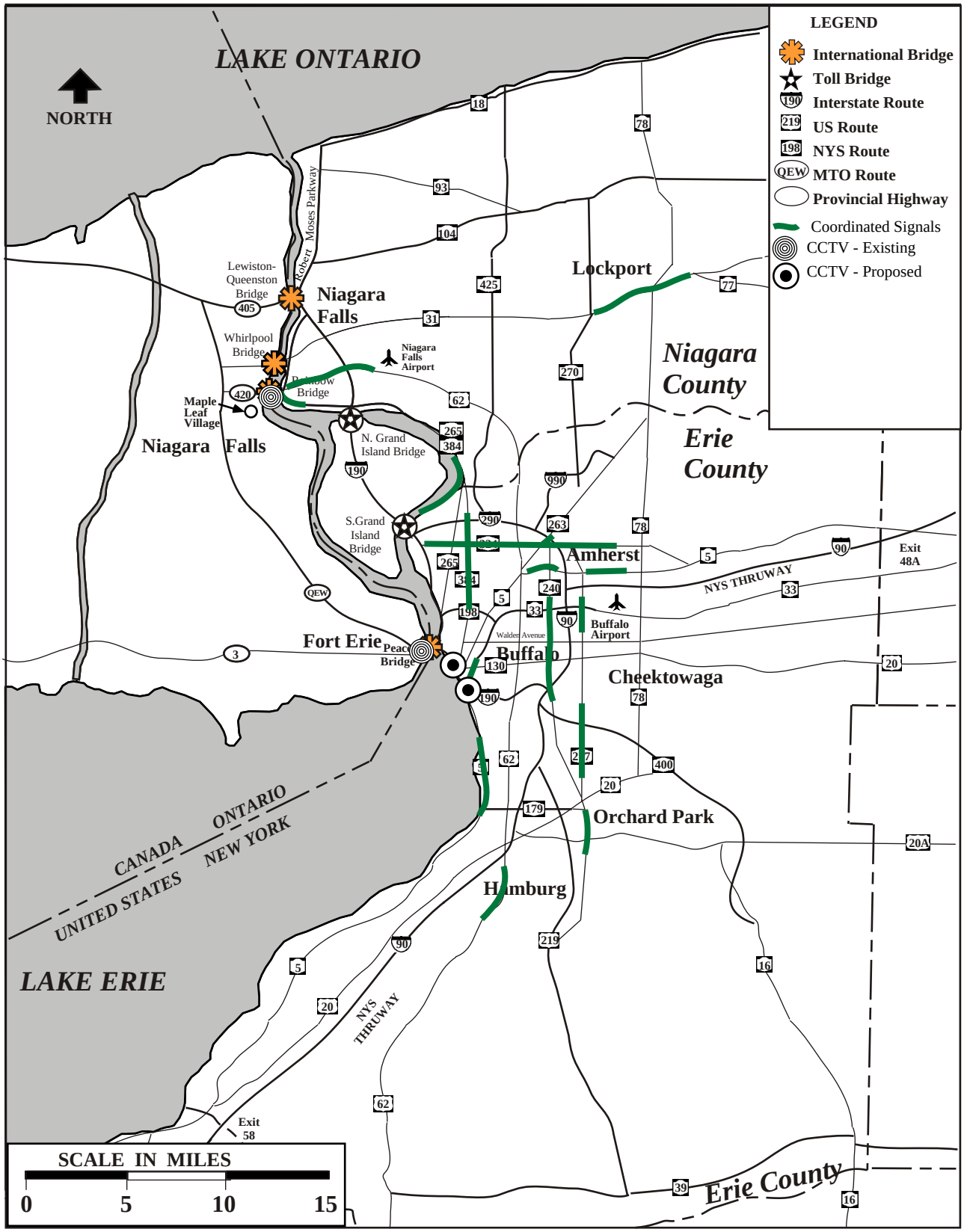

Figure 2-5 Coordinated Traffic Signals & Existing CCTV Locations

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3.0 INSTITUTIONAL ISSUES

Given the complexity of the region's existing transportation facilities and services along with those to be implemented in the future, there are institutional issues that must be recognized during the implementation of ITS on a regional basis. Agency autonomy, interagency agreements, privacy, and private sector motivation were the significant institutional issues raised during the outreach portion of this study.

3.1 AUTONOMY

Agencies expressed a concern about the need to share information while still retaining control. A multitude of agencies and divisions create a complex organizational challenge, and the agencies need to define and delineate their roles and develop coordination strategies. The development of a Regional Operations Center necessitates that the agencies work together to create these delineations and coordination strategies.

Systemwide response plans may need to be generated to handle accidents, breakdowns or other incidents. Arrangements need to be developed with both the operating and response agencies to allow for a coordinated response and a sharing of liability.

3.2 LEGALITIES - INTERAGENCY AGREEMENTS

The development of interagency agreements requires that legal staff be involved in the ITS planning process early on. Though public/private partnerships are highly desirable, there are no national guidelines regarding how to legislate the working relationship. In the future as the regional ITS grows, the agreements as well as liability sharing between public agencies and private firms will need to be addressed.

In developing a regional ITS, the transportation network should be "seamless," meaning that travelers moving between jurisdictions are unaware of information source or dissemination changes. Therefore the Buffalo/Niagara Falls ITS requires that information be shared between jurisdictions, and that agencies maintain a close working relationship. These tasks are particularly challenging in the region since travelers cross international as well as municipal boundaries.

3.3 PRIVACY

The institutional issue of privacy has both internal and external components. Internally, the issue is the security of the system, while externally the shared data or end use of the system must be addressed, to protect the privacy of travelers. The implementation of the Regional Operations Center will require information sharing between agencies. To maintain system security, agencies need to consider the following: physical access, passwords, data screening, one-way data flows, intermediate computers, and interagency agreements.

3.4 PRIVATE SECTOR MOTIVATION

Public agencies need to identify potential ITS products and services for private sector involvement, informing the private sector of potential benefits and emerging markets. Public agencies often find it difficult to invest in projects or products that are unproven. But given the likelihood of a reasonable return, private companies are willing to take the risk. The initial step is to provide as much information as possible to assist the private interests in assessing the market and developing the appropriate products.

4.0 USER NEEDS AND SYSTEM ARCHITECTURE

This section presents the assessment process of the transportation system and the determination of problems and needs in the Buffalo/Niagara Falls region.

4.1 DETERMINATION OF SYSTEM DEFICIENCIES

A system inventory, surveys, interviews, and an ITS User Services Workshop were used to determine problems and to begin identifying needed actions. Section 2 presented the results of the system inventory for this region.

4.1.1 Outreach Program

4.1.1.1 Critical Stakeholders

The critical stakeholders are those whose interests must be addressed to fairly allocate costs, benefits, control and liability. The stakeholders list was defined at the outset and refined during project planning, design and implementation. This group includes representatives from public and private agencies. The critical stakeholders were surveyed to identify both their concerns and their level of commitment to resolve the concerns. Table 4-1 is a listing of the critical stakeholders and whether they are a member of NITTEC or the Western New York Incident Management Team (WNYIMT).

4.1.1.2 Surveys

As part of this study, surveys were conducted to determine perceptions of traffic problems and the perceived ability of various ITS subsystems and communication systems to alleviate these problems. Two surveys were developed, one for agencies involved in transportation and the other for more general distribution to a cross-section of transportation system users from various backgrounds. An overall theme, in terms of both current function and potential ITS applications, was that funding and adequate staffing were major problems, followed closely by inter-agency cooperation, communication and jurisdictional barriers.

With respect to system objectives and performance measures, the agency respondents rated congestion reduction/travel time improvements and safety benefits as most important. Also, improved incident management, expedited border crossings and pre-clearance of commercial vehicles ranked high overall.

The respondents viewed ITS favorably. They indicated a willingness to support ITS via planning and design efforts, advisory roles and agency cooperation, even though they indicated their organizations lacked financial resources. In general, they found highway transportation to be more

Table 4-1 Critical Stakeholders

Agency / Organization	NITTEC	WNYIMT
Federal Highway Administration	x	x
New York State Department of Transportation	x	x
New York State Thruway Authority	x	x
Niagara Frontier Transportation Authority	x	x
Ministry of Transportation, Ontario	x	
Niagara County	x	x
Erie County	x	x
Niagara Falls, Ontario	x	
Niagara Falls, New York	x	
City of Buffalo	x	Police
Niagara Frontier Transportation Committee		x
Niagara Falls Bridge Commission	x	
Buffalo & Fort Erie Public Bridge Authority	x	
New York State Police Department		x
Greater Buffalo Partnership		
Automobile Association of America (Western and Central NY)		x
Tower Group International (CJ Tower, Inc.)		
Region of Niagara, Ontario	x	
Metro Networks		x
US Customs/Immigration & Naturalization Service		
Town of Fort Erie	x	
Niagara Parks Commission	x	
Canadian Automobile Association, Niagara		

important than public transportation. This result was reflective of the mission of the responding agencies.

Other problems were identified during an ITS User Services Workshop, held in June 1996. The workshop was attended by the critical stakeholders and members of NITTEC. The workshop was held to refine the transportation needs and proposed actions for the Buffalo/Niagara Falls transportation problems. Workshop attendees ranked the major categories of problems and needs in specific time frames. The attendees then developed a list of appropriate user services to implement the goals and objectives. User services are presented in Section 4.2 below. The ITS study team provided the necessary technical input and definitions of the user services to guide the attendees in their selections.

4.1.2 System Deficiencies

The determination of transportation problems in the Buffalo/Niagara Falls area was based upon review of the issues as defined quantitatively and qualitatively in the system inventory through the stakeholders survey and at the User Services Workshop. Deficiencies were determined to lie in the following areas, in descending order:

- Congestion
- Weather Related Conditions
- Safety/Incidents
- Border Crossings
- Interorganizational / International Cooperation
- Transit Services
- Funding
- Operations and Maintenance
- Recreational Travel / Tourism
- Privacy
- Public Support.

4.2 IDENTIFICATION OF USER SERVICES

To ensure that ITS programs developed for a region or locality have been developed to address specific user needs, the Federal Highway Administration (FHWA) has identified seven groups of 29 user services in the ITS National Program Plan (NPP), dated March 1995. It should be noted that as of June 1997 Highway-Rail Intersection will be added as the 30th user service. Communities may add area-specific user services.

The following list shows the five highest priority user services for the Buffalo/Niagara Falls region as determined from information obtained at the User Services Workshop:

- Traffic Control - This user service manages the movement of traffic on streets and highways, for example with coordinated traffic signals. This service is significant as it provides volumes, occupancies, and a communications infrastructure that can also be used by many other user services.

- Electronic Payment Service - This user service allows travelers to pay for transportation services electronically via automated collection systems such as electronic toll collection.

- Incident Management - This user service enhances existing capabilities for detecting incidents and improves incident response. Incident management includes techniques such as remote incident detection, notification and response as well as motorist assistance and obstruction removal.

- Interorganizational / International Management and Coordination (specific to Buffalo/Niagara Falls region) - This user service increases processing efficiency at border crossing, improves transit service and improves regional transportation system management by increasing coordination among various transportation system service providers and other pertinent agencies.

- Commercial Vehicle Electronic Clearance - This service allows enforcement personnel to electronically check safety, credentials, size, and weight for equipped vehicles before they reach an inspection site, in order to expedite commercial vehicles through weigh stations and international border crossings.

4.3 FUNCTIONAL REQUIREMENTS & MARKET PACKAGES

Market packages are groups of ITS projects defined within the National ITS Architecture Program. They address service requirements of ITS stakeholders and they consider the transportation architecture, communication infrastructure and institutional issues. For example the Network Surveillance Market Package integrates fixed roadside surveillance elements and the communication infrastructure necessary to transmit the surveillance data back to traffic management centers.

Market packages are designed separately or in combination to solve real world transportation problems and needs. Market packages are inter-related and are also dependent on external factors such as technology advancement, policy change, and development of common interface standards.

Market packages are grouped into the functional areas of Advanced Traffic Management Systems (ATMS), Advanced Traveler Information Systems (ATIS), Commercial Vehicle Operations (CVO), Emergency Management (EM), ITS Planning, Advanced Public Transportation Systems (APTS) and Advanced Vehicle Safety Systems (AVSS).

4.3.1 Functional Elements

Market packages can be defined in terms of functional elements (sensors, communications, interfaces, and control applications). The following are examples of the types of functional elements.

- Sensors - traffic, rail, vehicle status, environmental, vehicle monitoring, driver monitoring, cargo monitoring, obstacle ranging, lane tracking, security, and location determination.

- Communications - cell based, vehicle-to-roadside, vehicle-to-vehicle, fixed, algorithms, information management, and payment.

- Interfaces - driver interface, traveler interface and operator interface.

- Control Applications - signals, signs, and vehicle control.

4.3.2 Functional Requirements

The functional elements can be grouped together to provide specific functions such as "detect incident" or "communicate with emergency vehicles." A list of functions that could be provided with a regional ITS system was developed (and is presented in WP#4). The critical stakeholders rated each function as "required," "desired," or "not needed." From these responses, it was determined which of the functional elements would be necessary to implement specific market packages.

4.4 SYSTEM ARCHITECTURE

The conceptual system architecture is limited to the functional requirements and their inter-relationships, which follow the National Systems Architecture ITS program framework. More important, the created system architecture reflects the national Intelligent Transportation Infrastructure (ITI) components that have been identified as the building blocks of any ITS program within a metropolitan area.

The ITI refers to those portions of ITS-related hardware, software and services that today, and increasingly in the future, will support transportation-related activities. The ITI comprises nine components that are integrated to work together.

The nine ITI components are:

- Traffic Signal Control
- Freeway Management
- Transit Management
- Incident Management
- Regional Multi-Modal Traveler Information.
- Electronic Fare Payment
- Electronic Toll Collection
- Railroad Grade Crossings
- Emergency Management Services

A preliminary set of alternative architectures was presented and evaluated in this ITS study. While the overall analysis was kept at a conceptual level, a logical and structured evaluation was carried out to identify the best candidate architecture to satisfy all of the current functional requirements as well as future requirements for the Buffalo/Niagara Falls region.

The structured evaluation included defining the system users (user terminators), the necessary ITS subsystem and the available data sources. Each of these is defined below, followed by a discussion of the alternative architectures that were evaluated.

4.4.1 User Terminators

There are two types of users in the Buffalo/Niagara Falls ITS: travelers and operators.

4.4.1.1 Travelers

Travelers are key users of the Intelligent Transportation System for the Buffalo/Niagara Falls area. Travelers require pre-trip planning information and en-route information. Travelers can be in private vehicles, at home, in transit vehicles, in transit stations, on bicycles or on foot.

4.4.1.2 Operators

Operators request and receive information that is used in a variety of ways to facilitate efficient transportation throughout the region. Operators manage such systems as: the Regional Operations Center, other traffic operations centers, incident/emergency management and HAZMAT response teams, freeways, and tollways.

4.4.2 Necessary Subsystems of the ITS Architecture

The following list identifies the subsystems of the ITS Architecture that will be needed within the Buffalo/Niagara Falls Region:

- Traffic Control Subsystems - contains all the capabilities needed to manage traffic in arterial and freeway networks. These systems include incident detection and management as well as signal control.

- Transit Subsystems - performs the management functions related to fixed and flexible route transit services.

- Driver and Traveler Services - provides multi-modal trip planning, route guidance, and advisory functions for travelers of all types.

- Electronic Payment Services - responsible for the collection and management of toll payments, parking and other road pricing components.

- Commercial Vehicle Operations - responsible for providing facilities for management of commercial vehicles.

- Border Crossing Subsystem - provides commercial vehicle clearance screening facilities and management of commercial vehicles to expedite border crossings.

- Emergency Management Services - provides services related to emergencies that occur on the roadway. These services include emergency acknowledgement, notification to service

operators, response personnel and the motoring public, as well as coordination with the Traffic Control subsystems.

- Electronic Toll Subsystem - responsible for electronic toll payment functions throughout the region.

4.4.3 Data Sources

Traffic information gathering, processing and disseminating are basic to the ITS architecture. All data sources can be grouped into two major categories: fixed and mobile.

Fixed Data Sources-The fixed data sources range from field traffic and traveler information gathered by instrumentation, to information provided by other TOCs and related control and management centers. Roadside data sources gather information such as volume, speed, weight, vehicle length, and other information necessary for the implementation of various ITS market packages.

Mobile Data Sources - Mobile data sources include probes, electronic toll and traffic management equipped vehicles or Automatic Vehicle Identification (AVI) transit vehicles. The information collected from these sources includes travel times, routing information, emergency notification information, and other information that could be received from vehicles traveling throughout the region. This information is relayed through the use of either one-way or two-way communication technology.

4.4.4 Alternative Architectures

In determining the type of ITS architecture that should be implemented for the Buffalo/Niagara region, three options were reviewed:

- centralized
- partially decentralized
- distributed.

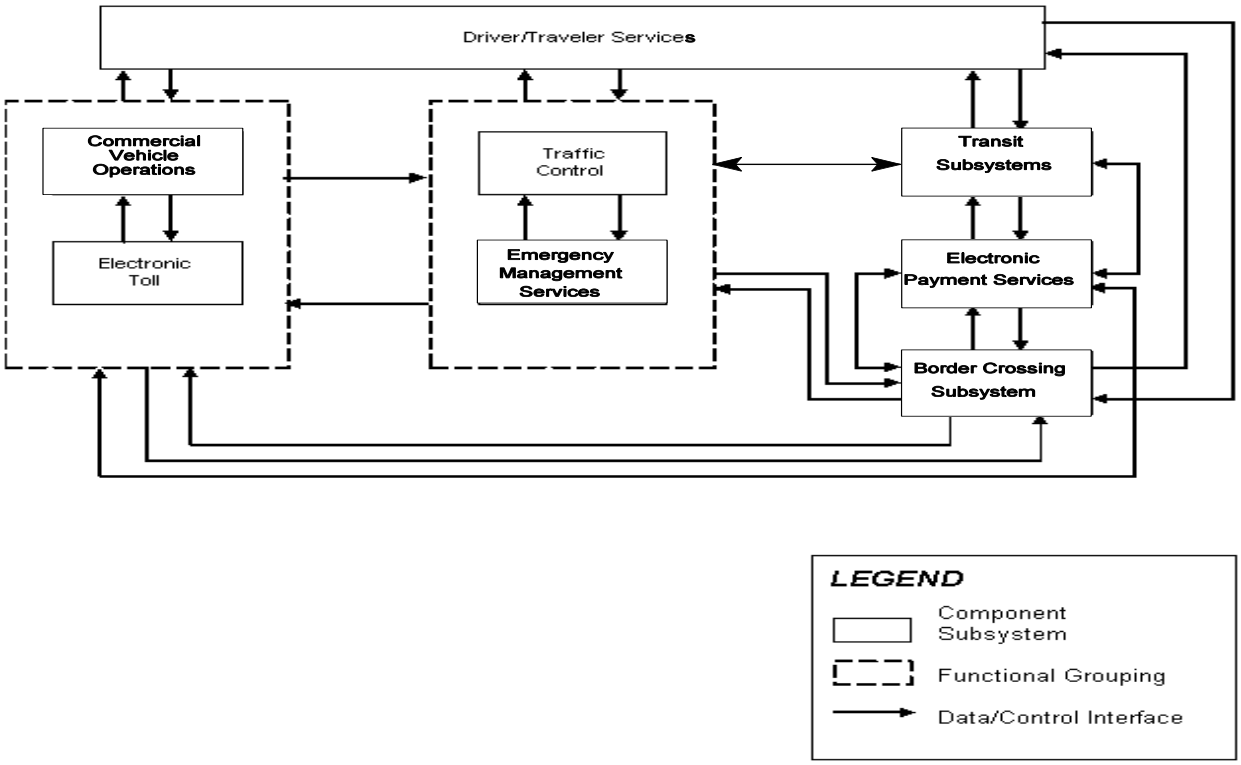
A comprehensive evaluation of all three architectures looked at seven different criteria:

- ability to meet users needs
- accessibility
- interactivity
- interoperability
- information sharing
- local needs
- cost minimization.

The partially decentralized architecture was determined to be best suited for this region. With the use of a partially decentralized architecture, most day-to-day operations will be distributed among

the respective physical subsystem operators and control centers, though control from a central point can occur. Figure 4-1 is a schematic representation of the recommended architecture.

Figure 4-1 Partially Decentralized Architecture



5.0 ALTERNATIVE TECHNOLOGIES

The System Architecture task for the Buffalo ITS identified the data sources needed, the system users, and the required subsystems. Once these were identified it was necessary to determine the technologies required to collect, transmit, process and disseminate the needed data to the system users and fulfill their ITS needs. During the study, multiple options for each of the basic elements of an ITS strategy were evaluated (information collection, communications, processing, and information dissemination) and a recommendation was made as to those most suited to the needs of the Buffalo/Niagara ITS. The following are the recommended ITS technologies for each of the elements. These are preliminary recommendations that must be reviewed and updated in preliminary and final design.

5.1 INFORMATION COLLECTION

- fixed detectors (non-intrusive) - the EIS RTMS microwave radar unit is a potentially acceptable detector. It will provide volumes, occupancies, and speed. One RTMS unit can be used to collect data for multiple lanes.

- fixed detectors (in roadway) - inductive loops are the only sensor technology which provides the range of measurement parameters required to support a variety of ITS functions.

- video detection system - the Econolite Autoscope Video Imaging 2004 for intersection video detection is recommended.

- moving detection - EZ-Pass is already widely in use; these transponders could be expanded for other uses (customs, immigration, safety). Information could also be sent out by these transponders for traffic management, travel information, and planning. GPS and cellular phones could also be used, if fully developed, for vehicle probes to supply traffic information.

- CCTV - the base technology should be color CCD (Charge Coupled Device), however, due to the multiple options available in CCTV technology, much of the final selection will depend on the final detailed design.

5.2 COMMUNICATIONS

The primary focus should be on a state-owned fiber optic SONET backbone for the region, which should be configured during design. The potential transmission of video over the SONET backbone will also be determined when the system is designed. Wireless technologies should be considered for remote installations where a backbone fiber link is impossible. Spread spectrum holds the most promise for these remote applications, since no FCC licensing is required, and the radio system would also be state-owned.

5.3 PROCESSING

For processing it is recommended that either Reduced Instruction Set Computers (RISC-based) or advanced personal computers (PC) systems be utilized. RISC-based systems reflect the state-of-the-art with respect to computing power and communication capabilities. Advanced PC technology has fully distributed networking capabilities which would allow greater interoperability and flexibility.

5.4 INFORMATION DISSEMINATION

- VMS - the recommended type of VMS is the LED style. LED VMS signs provide adequate visibility for all possible conditions.

- HAR - it is recommended that fixed 10W transmitter sites be utilized and placed at key nodes in the transportation network. These HARs would be provided with downloadable, location-specific messages that would be relayed to the nearby travelers. These should be configured during design.

6.0 STRATEGIC PLAN

The purpose of the strategic plan is to present a unified "road map" of ITS projects as well as to identify project participants. By indicating participants, the groundwork for needed institutional relationships is laid.

6.1 METHODOLOGY

To develop a complete ITS plan for the Buffalo/Niagara Falls region, two key steps have been taken. The first is to integrate existing ITS elements with proposed near term elements, to create an infrastructure foundation for future deployment initiatives. The second step is to lay out an implementation schedule that builds on the interrelationships between the various ITS elements.

6.2 PERFORMANCE CRITERIA

It is important that the ITS projects provide comprehensive system performance monitoring as part of each deployment action. ITS actions must be cost accountable in order to enjoy continued support and investment on the part of program stakeholders.

Some ITS features return benefits which are well demonstrated and easily quantifiable. For example, a number of toll road authorities throughout the U.S. have documented operational cost savings and improved throughput/revenues attributed to electronic toll collection. Other ITS features, such as reduced motorist delay due to incident management, are more difficult to quantify in monetary terms.

Criteria tables were developed (shown in Table 2-1 of Working Paper #7) that list the regional problems along with the resulting performance criteria. The criteria should be developed and refined in project design to provide useful measures-of-effectiveness that can be monitored and evaluated. Such measures will aid in further project development. An ongoing "before and after" evaluation process will provide a measure of ITS benefits. The results should be used in the development of system expansion.

6.3 INTERAGENCY COORDINATION EFFORTS

In the Buffalo/Niagara region, NITTEC and the Western New York Incident Management Team (WNYIMT) form the foundation for continuing evolutionary growth in ITS implementation. Both of these coalitions have improved cooperation between various agencies. Coordination of incident management across multiple jurisdictional levels has proven to be a major challenge in metropolitan areas across the U.S. Success in this area can serve as the handhold for technology implementation as well. The emphasis needs to be a long term, step-by-step process to realize the benefits of ITS. Only through cooperative, interagency efforts can ITS be successfully implemented regionwide.

6.3.1 NITTEC

The Niagara International Transportation Technology Coalition is an organization of agencies in the Niagara Frontier region of New York State and Ontario. Its mission is to improve regional and international transportation mobility, promote economic competitiveness, and minimize adverse environmental effects related to the regional transportation system, including the four highway border crossings between Canada and the United States within this region.

6.3.2 WNYIMT

The Western New York Incident Management Team is a consortium of public and private agencies that has been established to assist in emergency response and to enact a “clear road” policy. The team's goal is to integrate cooperation from nearly all emergency response providers and transportation agencies

6.4 PROJECT IMPLEMENTATION PRIORITIES

The ITS for the Buffalo/Niagara Falls region will be implemented on a project by project basis, therefore the culmination of this study is a list of deployment projects. Table 6-1 lists those ITS projects recommended for further development and associated market packages. Each project is listed along with the implementation time frame. Near term projects include all of the projects in the region that will be in place within 0 to 2 years (1996-1998). Mid term projects are those set to be implemented in the 3 - 7 year time frame (1999-2003). Long term projects are those which will be deployed in the 8+ year time frame (2004-2010+).

6.4.1 Summary of ITS Projects

A description of the existing, committed, and proposed projects (near, mid and long term) for the Buffalo/Niagara Falls ITS follows. Table 6-2 shows the capital costs and annual costs for each of the near and mid term projects.

Committed Near Term Projects:

- Installation of VMS and CCTV - this project includes the installation of 9 VMS (installed as of June 1997) and 2 CCTV within the Buffalo area.

- Installation of Vehicle Detector Stations - this project will result in a total of 137 permanent vehicle detector stations (PVDS) at various locations throughout the four county region.

- Early Implementation of Intelligent Transportation System - this project will include the installation of 6 VMS (installed as of June 1997) and 7 Roadway Weather Information Systems (RWIS).

- Electronic Toll Collection and Management - as part of the EZ-Pass Interagency Group (a coalition of seven toll authorities in New York, New Jersey, Delaware, and Pennsylvania), the NYSTA is deploying electronic toll collection and traffic management on its facilities. The NYSTA's aggressive program will result in the application of Automatic Vehicle Identification (AVI) technology to the 63 toll plazas of the Thruway's 641 mile system by the end of 1996.

- Video/Microprocessor Controlled Signals - a NYSDOT coordinated signal system is currently under construction along NY 5 (Fuhrmann Boulevard through Woodlawn, New York). This system will utilize cameras, fiber optic cable and microprocessors to control the signal timing.

- Signal Coordination Project - a major NYSDOT signal coordination study and implementation plan is currently being conducted by the NYSDOT for 219 signalized intersections throughout the region. The study will propose a system to be implemented in 1997, using time based coordination. Major roadways within the study include NY 5, NY 277, NY 20A, NY 78, NY 62, NY 324, NY 263, NY 354, and NY 384 in Erie County and NY 31, NY 62, NY 265, NY 425, and Rainbow Boulevard in Niagara County. Several other signal coordination projects have also been undertaken by NYSDOT and others.

- Signal Coordination Projects - the City of Buffalo has initiated a signal coordination study and implementation plan along the Franklin / Linwood arterial. This proposed study would entail approximately 6 signals within the City of Buffalo. An additional project will coordinate 100 downtown Buffalo signals.

- Peace Bridge Intelligent Transportation Border Crossing System (ITBCS) - this pilot study (originally "Michigan-Ontario-New York Border Crossing Initiatives") is being conducted to eliminate the need for exchange of "pre-cleared" paperwork at the border crossing. The commercial traffic will electronically transmit the documentation prior to arrival to the border crossing so that an instantaneous clearance can be made.

- Traffic Conditions Monitoring/Reporting - the NFTA Traffic Data and Information Dissemination is a free traffic information service. Information is gathered from Metro bus operators, New York State Police, Erie and Niagara County Sheriff Departments, and local police (from scanners). Metro Networks also provides traffic reporting services to major television stations and most of the radio market in Western New York.

- Existing Traffic Operations Center (PBA) - the Buffalo and Fort Erie Public Bridge Authority (PBA) operates out of the American Plaza at the Peace Bridge in Buffalo. Surveillance cameras and CCTV are used to identify incidents at the approaches to, and along the Peace Bridge. The center controls one VMS and several fixed message signs.

- Existing Traffic Operations Center (NYSTA) - the New York State Thruway Authority (NYSTA) operations are controlled from the local NYSTA headquarters in Cheektowaga. The regional traffic supervisor has the responsibility of operating the VMSs and HAR from this facility.

- Existing Traffic Operations Center (NITTEC/NYSDOT and Buffalo Police) - when unsafe driving conditions are determined to exist on the Skyway (NY 5) elevated expressway by the Buffalo Police, the Skyway is closed. Via modem, a message is sent from a workstation at the interim ROC by the Buffalo Police Department to the fixed message signs and flashing amber lights at both ends of the Skyway.

  The interim ROC, currently operated by the NYSDOT, collects and distributes information on road maintenance and weather conditions.

- Existing Traffic Operations Center (NFBC) - the NFBC utilizes surveillance cameras, CCTV and FMS to identify and report incidents along the Rainbow Bridge. This system is operated from the Canadian side of the Rainbow Bridge.

- Existing Traffic Operations Center (NFTA) - the NFTA operates a transit control center located on Oak Street in downtown Buffalo. The center includes train (Light Rail Rapid Transit-LRRT) operation controls, signal controls, CCTV and an extensive communications system.

- Automatic Vehicle Location System - the NFTA has a contract to install Automatic Vehicle Location (AVL) devices on all NFTA buses, paratransit vehicles, internal police cars, supervisor cars, and money trucks (over 370 vehicles total). Using Global Position Satellite (GPS) technology over microwave radio, the AVL system will locate vehicles and yield travel time data at on-minute resolution.

- Existing Travel Advisory Radio - the Niagara Parks Commission and the Niagara Falls Bridge Commission jointly operate a Traveler Traffic Information Radio Station (Travel Advisory Radio), CFLZ 91.9 FM. The station broadcasts from the Skylon Tower in Niagara Falls, Ontario at 35 watts.

- Existing Highway Advisory Radio - the NYSTA operates a HAR system on 1017 AM. The coverage is shown on Figure 2-4.

- Existing Weather Advisory Radio - the National Oceanic and Atmospheric Administration weather radio station (funded/operated by the United States Department of Commerce) at the Buffalo Airport (KEB98 @ 1625.5AM) reports weather conditions for the area with a coverage of approximately a 40 mile radius.

Proposed Near Term Projects:

- Upgrade Regional Operations Center - upgrades the interim ROC to provide joint operational integration of the Niagara region's existing VMSs, CCTV, HAR, weather stations, emergency response systems and event management, under the direction of NITTEC. Interagency relationships need to be worked out.

- Freeway Traffic Management System (FTMS) Stage I - involves the installation of ITS elements and creation of an FTMS along NY33 (Elm/Oak arterials to I-90), I-90 (NY 33 to I-290), and NY 198 (NY 33 to Parkside Interchange). Figure 6-1 shows the limits of the proposed FTMS. FTMS elements include vehicle detector stations, closed circuit television cameras, highway advisory radio, variable message signs and a communications network. It should be noted that ramp metering stations (RMS) were also considered as an FTMS element, but due to geometric constraints (i.e. insufficient ramp storage and subsequent short acceleration distances) and political considerations, RMS was not included.

- ROC Information Exchange Network (IEN) - establishes an electronic information system to interconnect the primary operations and information centers at the intra-regional level. The ROC will act as the communications hub.

These near term projects provide the base for the Buffalo/Niagara Falls ITS. The upgraded ROC will enable improved management and coordination of the region's transportation system. The first stage of the FTMS provides much needed surveillance data to the ROC and improves upon data dissemination to the travelers. These proposed near term projects have an estimated capital cost of $5.6 million.

Proposed Mid Term Projects:

- Interconnect to Mayday System - provides a communications interface between the Mayday Information Service Provider and the 911 emergency system.

- FTMS Staged Expansion - expands upon the existing, committed and near term FTMS elements. Expansion will include the installation of an FTMS along I-290 (I-990 to I-90), NY 33 (I-90 to Buffalo International Airport), NY 198 (I-190 to Parkside),and I-90 (Kensington Expressway south to the vicinity of US-219). See Figure 6-1.

- Common Smart Card Project - will evaluate, recommend and implement a single smart card medium for use within the region for all transportation related tolls and fares. This would include parking, transit and tolls.

- Signal Coordination and Closed Loop Signal Applications Project - provide signal coordination and/or closed loop signal applications as necessary to achieve positive coordination between FTMS and local roadways during incident management, special event management and other traffic management strategies.

- Arterial Bus Priority Demonstration Project - provides bus priority for the signalized intersections along a 5 mile arterial corridor in the Buffalo/Niagara Falls region. Arterial to be determined.

- Road Weather Information System Interconnect - will interconnect all weather/data stations in the project area and integrate them with the ROC.

- Pre-Trip Traveler Information - will develop the interfaces that would allow users access to pre-trip travel information, e.g., at kiosks.

- Intelligent Transportation Border Crossing System (ITBCS) Expansion Project - will utilize the initial ITBCS project (Peace Bridge) as a base to expand the system to all four border crossings in the region. Included would be communication links and necessary processing functions. Communication links with the ROC will also be created.

- Roving Service Patrol - this emergency/incident response program will schedule 4 roving vehicles to traverse the two ring roads and NY 33 in the AM and PM peak periods. The vehicles will be equipped to service most stalled vehicles.

These nine proposed mid term projects, with a capital cost of $21.5 to $25.7 million, create a multimodal ITS. By incorporating the single smart card throughout the region, travel on public transit will become easier. Additionally, the bus priority demonstration project can provide improved operations to the transit system. These projects also help to relieve congestion on more of the roadway system with improved travel advisories, increased throughput and a better management.

Proposed Long Term Projects:

- Staged Expansion of the FTMS - the FTMS will be completed. Possible additional roadways for FTMS coverage include I-290, I-990, I-190, I-90, NY 400, NY 5, US 219 and the Robert Moses Parkway. See Figure 6-1.

- Advanced Vehicle Control System (Collision Avoidance) - utilizes the developments of the automotive industry and other private design firms. It is unknown at this time what technologies will be available or what the state-of-the-practice will be.

- Support for In-Vehicle Route Guidance Systems - consists of in-vehicle equipment and radio based messaging to provide drivers with travel advisories.

- En-Route Transit Information - will allow communication interfaces to transmit bus arrival times and travel times to transit riders while en-route as well as in the bus terminals via kiosks.

- Signal Coordination and Closed Loop Signal Applications - provide signal coordination and/or closed loop signal applications as necessary to achieve positive coordination between FTMS and local roadways during incident management, special event management and other traffic management strategies.

The long term staged expansion of the FTMS system will complete the system for efficient freeway management. The major freeway routes will be under surveillance, and information will be conveyed to the motorists in a timely manner to promote re-routing. The technologies to implement many of these long term projects are currently evolving.

6.4.2 Relative Benefits

With a full implementation of incident detection, the savings to transportation users should be considerable. Automated incident detection programs lead to faster incident response time. Other incident management programs have been able to achieve response times up to 8 minutes faster, leading to a significant decrease in motorist delay and inconvenience. The Institute of Transportation Engineers estimates up to a 42% decrease in travel times for incident management programs.

Provided with travel information and road/weather information before they make a trip (pre-trip), motorists are twice as likely to use an alternative route. By avoiding a congested area, motorists improve overall system performance. Travel time decreases of up to 20% under adverse conditions can be expected.

Electronic Fare Payment Systems like the Common Smart Card project offer convenience to not only the service user, but the service provider. By using the same electronic media for transit, parking, and tolls, non-cash transactions ease money handling by the service providers and provide improved database tracking capabilities of personal trip and origin-destination patterns.

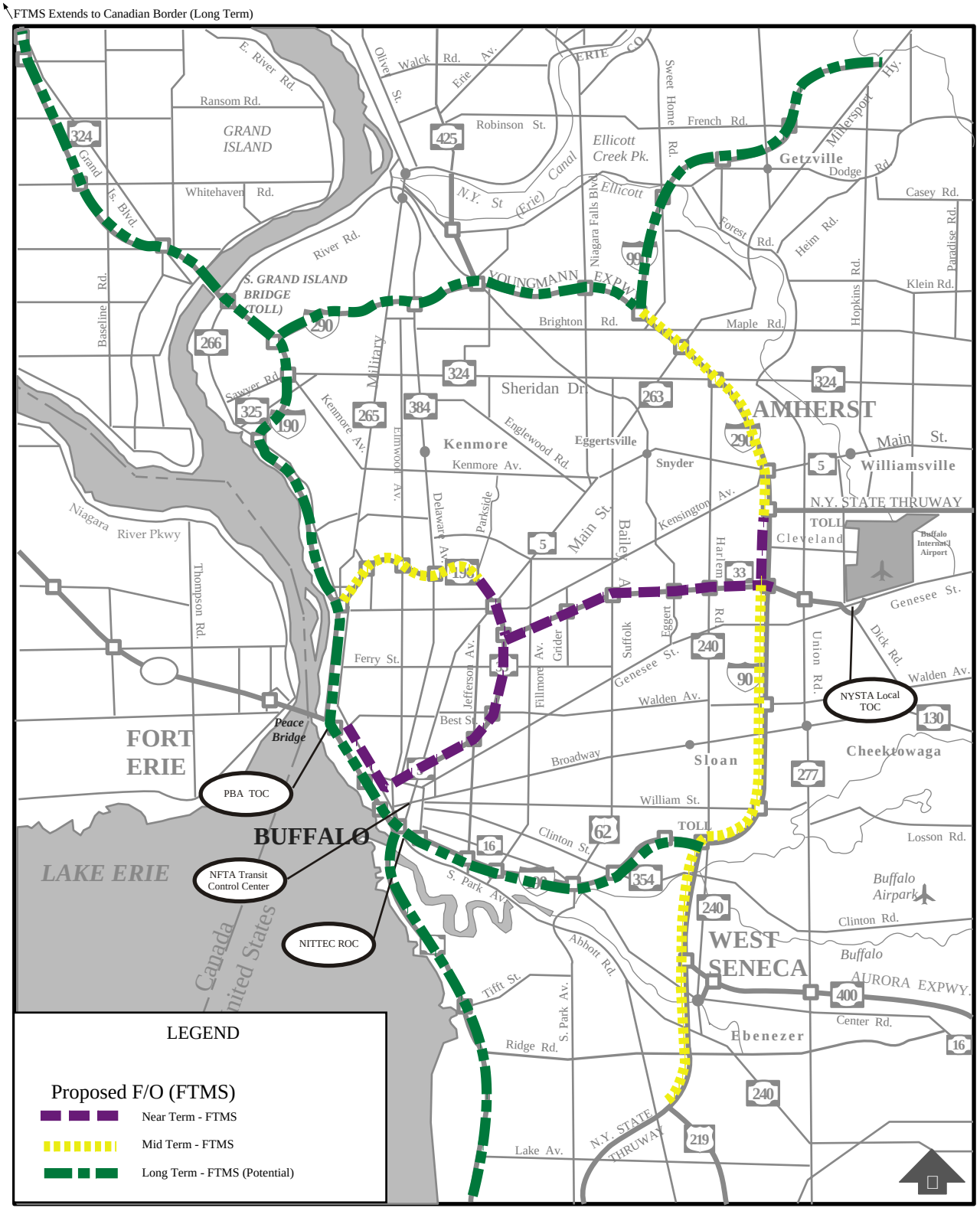


Figure 6-1 Freeway Traffic Management System (FTMS)

Table 6-1 Proposed Project Summary

PROJECT NAME	IMPLEMENTATION TIME FRAME	PROJECT STATUS
Electronic Fare Collection (Dynamic Toll/Parking Fee Management Market Packages)[1]		
Common Smart Cards for Thruway, transit systems, Peace Bridge, etc.	Mid Term	Proposed
Signal Coordination (Surface Street Control Market Packages)		
NYSDOT Video/microprocessor Controlled Signals (with F/O interconnect) NY 5 Fuhrmann Blvd thru Woodlawn)	Near Term	Hardware in place 1996
NYSDOT Signal Coordination Project (219 Signals) (5803.39)	Near Term	1998
Signal Coordination and Closed Loop Signal Applications	Mid Term	Proposed
Signal Coordination and Closed Loop Signal Applications	Long Term	Proposed
Bus Priority on Local Arterial - Demonstration Project	Mid Term	Proposed
Electronic Clearance (Electronic Clearance Market Packages)		
Peace Bridge Intelligent Transportation Border Crossing System (5804.35)	Near Term	1997
Expand Intelligent Border Crossing System project to all crossings	Mid Term	Proposed
Monitoring/Information Dissemination (Network Surveillance Market Packages & Traffic Information Dissemination Market Packages)		
NFTA Automatic Vehicle Location (AVL)	Near Term	1997
NYSDOT Installation of Vehicle Detection Stations (Counters 97 loc's)	Near Term	1997
NYSTA Installation of CCTV & VMS (I-190 Carolina interchange; I-190 Skyway) (TAB 95-63S)	Near Term	1997
NYSDOT Early Implementation of ITS (6 VMS, 7 RWIS, & 3 FMS - Skyway) PIN5803.38 D256835	Near Term	Early 1997
FTMS - Stage I (CCTV, PVDS Upgrade, VDS, COM System, VMS, & HAR)	Near Term	Proposed

[1] Market Packages are defined in detail in Section 2.1 Working Paper # 4, *Functional Requirements*.

Table 6-1 Proposed Project Summary

PROJECT NAME	IMPLEMENTATION TIME FRAME	PROJECT STATUS
Staged expansion of FTMS (CCTV, AVI Readers, PVDS Upgrade, VDS, COM System, VMS, & HAR)	Mid Term	Proposed
Staged expansion of FTMS (CCTV, AVI Readers, PVDS Upgrade, VDS, COM System, VMS, & HAR)	Long Term	Proposed
NYSTA Highway Advisory Radio	Near Term	In Place
Traffic Operations Centers (Regional Traffic Control Market Package)		
NITTEC ROC Upgrade (5804.08)	Near Term	Proposed
NITTEC ROC Information Exchange Network (5804.08)	Near Term	Proposed
Incident Management Program (Incident Management System Market Packages)		
Roving Service Patrol	Mid Term	Proposed
Interconnect to Mayday System	Mid Term	Proposed
Advanced Vehicle Control System (Collision Avoidance)	Long Term	Proposed
Multimodal Traveler Information (Broadcast Traveler Information Market Package & Interactive Traveler Information Market Package)		
Pre-Trip Traveler Information (WEB page, radio, TV, kiosks in transit areas)	Mid Term	Proposed
Road Weather Information System Interconnect	Mid Term	Proposed
Support for in-vehicle route guidance systems TRIS, Toronto expansion to Buffalo	Long Term	Proposed
En-Route Transit Information	Long Term	Proposed

Table 6-2 Capital and Annual Operating & Maintenance Costs for Proposed Near and Mid Term Projects

PROJECT	CAPITAL COSTS	ANNUAL OPERATING COSTS	ANNUAL MAINTENANCE COSTS
NEAR TERM			
5804.08 ROC Upgrade	$896,000	$112,000 to $146,000	$50,000
5804.08 FTMS Stage I	$4,650,600	$17,400	$465,060
5804.08 ROC IEN	$105,000	(1)	$60,000
Near Term Summary	$5,651,600	$129,400 to $163,400	$575,060
MID TERM			
Mayday	$24,000	$12,000	-
FTMS Expansion	$5,686,100	(1)	$568,610
Signal Coord & Closed Loop Signal Application	$200,000	$20,000	$20,000
Arterial Bus Priority	$199,500	(2)	$19,950
Universal Smart Card	$9,466,000	(2)	$946,600
RWIS	$112,000	(1)	$11,200
Pre-Trip Travel	$1,000,300	(2)	$100,000
ITBCS Expansion Project	$4,200,000 to $8,400,000	(2)	$420,000 to $840,000
Roving Service	$650,000	$125,000 to $333,000	$65,000
Mid Term Summary	$21,537,900 to $25,737,900	$157,000 to $365,000	$2,151,360 to $2,571,360
TOTAL	$27,189,400 to $31,389,400	$286,400 to $528,400	$2,726,420 to $3,146,420

(1) Operating Cost included in ROC operating cost
(2) Minimal annual operating cost included in maintenance cost.

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